RTCA Special Committee 186, Working Group 3

ADS-B 1090ES MOPS

Meeting #20

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Proposed Test Procedures to add to the Proposed "Change 1" to RTCA/DO-260A

Robert Saffell
Rockwell Collins

SUMMARY

This Working Paper identifies test procedures that we feel need to be added to the Change 1 to DO-260A in order to check for the CPR boundary conditions.

Required amendments to Test Procedures in DO-260A to implement minimum appropriate CPR Decoder Testing:

Note: **Areas that are highlighted in "Yellow" need to be adjusted for hyperlink once added to the main document.**

2.4.10.3.1 Verification of the Report Assembly Acquisition State --- Airborne Participant (2.2.10.3.1)

Measurement Procedure:

Step 1: Globally Unambiguous CPR Decode

Replace the existing Step 1 paragraphs with the following:

a. For each row in Table 2.4.10.3.1, provide the CPR Decoder function with the **"odd"** and **"even"** Airborne Encodings. Provide the **"odd"** and **"even"** Encodings to the CPR Decoder function (see §A.1.7.7 of Appendix A) within ten (10) seconds of each other.

Table 2.4.10.3.1: Input Data for Global Unambiguous Airborne Decode Zone Check

Input Data for Global Unambiguous Airborne Decode Zone Checks										
	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				Even Airborne Encoding			Odd Airborne Encoding		
Row	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	10D8D	53	0D79C	033F0	53
2	27.938976	13DE22A7	45.0000	20000000	15020	14000	53	12864	10000	53
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	033F0	**52**	0D79C	033F0	53
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	10D8D	53	0D79C	15A53	**52**
5	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFE0	033F0	**52**	0D79C	15A53	**52**

b. For row 1 and 2 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) provides an output **latitude** position within **0.00015** degrees of the **latitude** position indicated for rows 1 and 2.

c. For row 1 and 2 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) provides an output **longitude** position within **0.00015** degrees of the **longitude** position indicated for rows 1 and 2.

d. For row 3 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) does **not** provide an output **longitude** position that is consistent with the **longitude** position indicated for row 3.

Note: *The **"even"** encoding for row 3 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position. This condition can be corrected if the Decoder function has prior knowledge of the expected position. However, correction is not recommended since the Global Decode assumes that there is no prior knowledge of the position.*

e. For row 4 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) does **not** provide an output **longitude** position consistent with the **longitude** position indicated for row 4.

Note: *The **"odd"** encoding for row 4 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position. This condition can be corrected if the Decoder function has prior knowledge of the expected position. However, correction is not recommended since the Global Decode assumes that there is no prior knowledge of the position.*

f. For row 5 in Table 2.4.10.3.1, verify that the CPR Decoder function (see §A.1.7.7 of Appendix A) does **not** provide an output **longitude** position consistent with the **longitude** position indicated for row 5.

Note: *The **"odd"** and **"even"** encodings for row 5 have been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in the Decoder Function selecting NL **"odd"** equal to NL **"even"** and will produce what appears to be a valid decode of the position. However, the decoded position will not be consistent with the position indicated for row 5 in Table 2.4.10.3.1 and should be discarded.*

g. If the CPR Decoder function (see §A.1.7.7 of Appendix A) does not provide the appropriate results in subparagraph b -through- f, then verify that the decoded position is discarded by the CPR Decoder function.

h. Using the Airborne scenario and simulation set up in Step 1 of §2.4.10.1.3 above, verify that for each Participant for which and **"even"** and an **"odd"** pair of encoded Airborne Position Messages is received within a ten (10) second period that the Report Assembly Function correctly performs a successful Globally Unambiguous CPR Decode in accordance with §A.1.7.7 of Appendix A.

2.4.10.3.2 Verification of the Report Assembly Acquisition State --- Surface Participant (2.2.10.3.2)

Purpose / Introduction:

Directly after Purpose/Introduction and before the existing first paragraph, insert the following paragraph.

Verify that the Decoder Function properly executes Globally Unambiguous Surface decodes in accordance with §A.1.7.8 of Appendix A when latitude position is close to a transition boundary.

Measurement Procedure:

Step 1: Locally Unambiguous CPR Decode

Replace the existing Step 1 paragraphs with the following:

Step 1: Globally Unambiguous CPR Decode

a. For each row in Table 2.4.10.3.2, provide the CPR Decoder function with the **"odd"** and **"even"** Surface Encodings. Provide the **"odd"** and **"even"** Encodings to the CPR Decoder function (see §A.1.7.8 of Appendix A) within fifty (50) seconds of each other.

Table 2.4.10.3.2: Input Data for Global Unambiguous Surface Decode Zone Check

Input Data for Global Unambiguous Surface Decode Zone Checks										
	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				Even Surface Encoding			Odd Surface Encoding		
Row	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	0CFC1	53
2	27.938976	13DE22A7	45.0000	20000000	14081	10000	53	0A190	00000	53
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	0CFC1	53
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	1694C	**52**
5	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	1694C	**52**

b. For row 1 and 2 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) provides an output **latitude** position within **0.00015** degrees of the **latitude** position indicated for row 1 and 2.

c. For row 1 and 2 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) provides an output **longitude** position within **0.00015** degrees of the **longitude** position indicated for row 1 and 2.

d. For row 3 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) does **not** provide an output **longitude** position consistent with the **longitude** position indicated for row 3.

Note: *The **"even"** encoding for row 3 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position. This condition can be corrected if the Decoder function has prior knowledge of the expected position. However, correction is not recommended since the Global Decode assumes that there is no prior knowledge of the position.*

e. For row 4 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) does **not** provide an output **longitude** position consistent with the **longitude** position indicated for row 4.

Note: *The **"odd"** encoding for row 4 has been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in significant error in the decoded position. This condition can be corrected if the Decoder function has prior knowledge of the expected position. However, correction is not recommended since the Global Decode assumes that there is no prior knowledge of the position.*

f. For row 5 in Table 2.4.10.3.2, verify that the CPR Decoder function (see §A.1.7.8 of Appendix A) does **not** provide an output **longitude** position consistent with the **longitude** position indicated for row 5.

Note: *The **"odd"** and **"even"** encodings for row 5 have been established by forcing the NL lookup to **52** for encoding as opposed to **53**. This will result in the Decoder Function selecting NL **"odd"** equal to NL **"even"** and will produce what appears to be a valid decode of the position. However, the decoded position will not be consistent with the position indicated for row 5 in Table 2.4.10.3.2 and should be discarded.*

g. If the CPR Decoder function (see §A.1.7.8 of Appendix A) does not provide the appropriate results in subparagraph b -through- f, then verify that the decoded position is discarded by the CPR Decoder function.

h. Using the Surface scenario and simulation set up in Step 2 of §2.4.10.1.3 above, verify that for each Participant for which an **"even"** and an **"odd"** pair of encoded Surface Position Messages is received within a fifty (50) second period that the Report Assembly Function correctly performs a successful Globally Unambiguous CPR Decode in accordance with §A.1.7.8 of Appendix A.

2.4.10.4.1.1 Verification of the Report Assembly Track State --- Airborne Participant (2.2.10.4.1.1)

Purpose / Introduction:

Directly after Purpose/Introduction and before the existing first paragraph, insert the following paragraph.

Verify that the Decoder Function properly executes Local Unambiguous Airborne decodes in accordance with §A.1.7.5 of Appendix A when latitude position is close to a transition boundary.

Measurement Procedure:

Step 1: Set the Report Mode to Track

Replace the existing Step 1 paragraphs with the following:

Step 1: Locally Unambiguous CPR Decode and Set Report Mode to Track

a. For each row in Table 2.4.10.4.1.1, provide the CPR Decoder function (see §A.1.7.5 of Appendix A) with the **"odd"** and **"even"** Airborne Encodings within five (5) seconds of each other.

Table 2.4.10.4.1.1: Input Data for Local Unambiguous Airborne Decode Zone Checks

Input Data for Local Unambiguous Airborne Decode Zone Checks											
	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				Even Airborne Encoding			Odd Airborne Encoding			
Row	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL	
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)	Notes
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFEO	10D8D	53	0D79C	033F0	53	1
2	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFEO	033F0	**52**	0D79C	033F0	53	2
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFEO	10D8D	53	0D79C	15A53	**52**	3
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0AFEO	033F0	**52**	0D79C	15A53	**52**	4

Notes:

1. The input position of the decoder is as given in Row 1 and the **"even"** and **"odd"** Encodings use the proper NL=**53** zone for Encoding.
2. The NL was forced to **52** (e.g., the next closest zone) for Encoding of the **"even"** Airborne Encoding and should result in a decoded longitude position of approximately 150.1229992 degrees for the "even" decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookup is based on the encoded latitude the initial NL lookup will be 53. The Decoder function will have to change this to 52 and then re-compute the longitude position in order to correct the longitude error.
3. The NL was forced to **52** (e.g., the next closest zone) for Encoding of the **"odd"** Airborne Encoding and should result in a decoded longitude position of approximately 150.067485 degrees for the **"odd"** decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookup is based on the encoded latitude the initial NL lookup will be 53. The Decoder function will have to change this to 52 and then re-compute the longitude position in order to correct the longitude error.
4. The NL was forced to **52** (e.g., the next closest zone) for Encoding of both **"even"** and **"odd"** Airborne Encoding and should result in a decoded longitude position of approximately 150.122992 degrees for the **"even"** decode and 150.067485 degrees for the **"odd"** decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookups are based on the encoded latitudes the initial NL lookups will be 53. The Decoder function will have to change these to 52 and then re-compute the longitude positions in order to correct the longitude errors.

b. For row 1 –through- 4 in Table 2.4.10.4.1.1, verify that the CPR Decoder function (see §A.1.7.5 of Appendix A) provides an **"even"** and **"odd"** output **latitude** position within **0.00015** degrees of the **latitude** position indicated for each row in Table 2.4.10.4.1.1.

c. For row 1 –through- 4 in Table 2.4.10.4.1.1, verify that the CPR Decoder function (see §A.1.7.5 of Appendix A) provides an **"even"** and **"odd"** output **longitude** position within **0.00015** degrees of the **longitude** position indicated for each row in Table 2.4.10.4.1.1.

d. If the CPR Decoder function (see §A.1.7.5 of Appendix A) does **not** provide the appropriate results in subparagraph b -through- c, then verify that the decoded position is discarded by the CPR Decoder function.

e. Start this test procedure step with the assumption that for a given Airborne Participant, the Acquisition State has been established in accordance with the Test Procedures in §2.4.10.3.1.

Verify that for each Participant in the Airborne scenario and simulation set up in Step 1 of §2.4.10.1.3 above, where it has been verified that the Acquisition State has been established, and upon receipt of the first Airborne Velocity Message for the given Participant, verify that the Report Assembly Function correctly sets the Report Mode to "Track" in the State Vector Report in accordance with the formatting in §2.2.8.1.22.

2.4.10.4.2.1 Verification of the Report Assembly Track State Initialization --- Surface Participant (2.2.10.4.2.1)

Purpose / Introduction:

Directly after Purpose/Introduction and before the existing first paragraph, insert the following paragraph.

Verify that the Decoder Function properly executes Local Unambiguous Surface decodes in accordance with §A.1.7.6 of Appendix A when latitude position is close to a transition boundary.

Measurement Procedure:

Create a new Step 1 immediately after the Measurement Procedure:

Step 1: Local Unambiguous CPR Decode

a. For each row in Table 2.4.10.4.2.1, provide the CPR Decoder function (see §A.1.7.6 of Appendix A) with the "odd" and "even" Surface Encodings within five (5) seconds of each other.

Table 2.4.10.4.2.1: Input Date for Local Unambiguous Surface Decode Zone Check

Input Data for Local Unambiguous Surface Decode Zone Checks											
	Angular Weighted Binary (AWB)Position of the Encoder in Degrees				Even Surface Encoding			Odd Surface Encoding			
Row	Latitude		Longitude		Lat.	Lon.	NL	Lat.	Lon.	NL	
	(Decimal)	(HEX)	(Decimal)	(HEX)	(HEX)	(HEX)	(Dec.)	(HEX)	(HEX)	(Dec.)	Notes
1	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	0CFC1	53	1
2	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	0CFC1	53	2
3	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	03636	53	15E70	1694C	**52**	3
4	-27.93897726	EC21DD4A	153.00998	6CCE9DE7	0BF7F	0CFC1	**52**	15E70	1694C	**52**	4

Notes:

1. The input position of the decoder is as given in Row 1 and the **"even"** and **"odd"** Encodings use the proper NL=**53** zone for Encoding.
2. The NL was forced to **52** (e.g., the next closest zone) for Encoding of the **"even"** Surface Encoding and should result in a decoded longitude position of approximately 0.5092509 degrees for the **"even"** decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookup is based on the encoded latitude the initial NL lookup will be 53. The Decoder function will have to change this to 52 and then re-compute the longitude position in order to correct the longitude error.
3. The NL was forced to **52** (e.g., the next closest zone) for Encoding of the **"odd"** Surface Encoding and should result in a decoded longitude position of approximately 0.5190433 degrees for the **"odd"** decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookup is based on the encoded latitude the initial NL lookup will be 53. The Decoder function will have to change this to 52 and then re-compute the longitude position in order to correct the longitude error.
4. The NL was forced to **52** (e.g., the next closest zone) for Encoding of both **"even"** and **"odd"** Surface Encoding and should result in a decoded longitude position of approximately 0.5092509 degrees for the **"even"** decode and 0.5190433 degrees for the **"odd"** decode if the receiver decoder does not recognize the boundary condition. Since the Decoder NL lookups are based on the encoded latitudes the initial NL lookups will be 53. The Decoder function will have to change these to 52 and then re-compute the longitude positions in order to correct the longitude errors.

b. For row 1 –through- 4 in Table 2.4.10.4.2.1, verify that the CPR Decoder function (see §A.1.7.6 of Appendix A) provides an **"even"** and **"odd"** output **latitude** position within **0.00015** degrees of the **latitude** position indicated for each row in Table 2.4.10.4.2.1.

c. For row 1 –through- 4 in Table 2.4.10.4.2.1, verify that the CPR Decoder function (see §A.1.7.6 of Appendix A) provides an **"even"** and **"odd"** output **longitude** position within **0.00015** degrees of the **longitude** position indicated for each row in Table 2.4.10.4.2.1.

d. If the CPR Decoder function (see §A.1.7.6 of Appendix A) does **not** provide the appropriate results in subparagraph b -through- c, then verify that the decoded position is discarded by the CPR Decoder function.

Step 2: Track State Initialization

Put the existing paragraphs a, b, c, and d here and adjust alignment.

END of Added Procedures: